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Diagnostic Utility of Triphasic Multidetector CT in the Evaluation of Focal Liver Lesions: An Observational Study

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Abstract

Background: Focal liver lesions comprise a wide spectrum of benign and malignant pathologies whose reliable non-invasive characterization is essential for treatment planning.

Aim: To evaluate the diagnostic utility of triphasic multidetector CT (MDCT) in characterizing focal liver lesions based on phase-specific enhancement patterns.

Materials and Methods: This prospective observational study enrolled 85 patients with suspected liver lesions who underwent triphasic MDCT on a 128-slice scanner, with arterial phase acquisition at 30–40 seconds, portal venous phase at 70 seconds, and delayed phase at 180 seconds after contrast injection. Demographic data, lesion morphology, phase-wise enhancement pattern, background hepatic parenchyma, and final CT diagnosis were recorded and analyzed using SPSS version 21.

Results: Hemangioma (20.0%), metastasis (17.6%), and hepatocellular carcinoma (HCC, 16.5%) were the commonest diagnoses. HCC showed arterial enhancement in 64.3% of cases with washout in 57.1%, and was strongly associated with cirrhosis (54.5%, $p<0.001$). Hemangiomas showed classic peripheral nodular enhancement with centripetal fill-in (47.1%). Metastases showed heterogeneous, frequently multifocal (86.7%) enhancement.

Conclusion: Triphasic MDCT reliably differentiates focal liver lesions through characteristic phase-specific enhancement patterns, supporting its role as a first-line, non-invasive modality for hepatic lesion characterization.

Keywords: Liver Neoplasms, Multidetector Computed Tomography, Hepatocellular Carcinoma, Hemangioma, Liver Metastasis.

Introduction

Focal liver lesions represent a heterogeneous group of pathologies ranging from benign entities such as hemangioma and focal nodular hyperplasia (FNH) to malignant tumors including hepatocellular carcinoma

(HCC) and metastases1. Accurate, non-invasive characterization is critical for treatment planning and prognostication. Multidetector CT (MDCT) has become central to hepatic imaging because of its high spatial and temporal resolution and its capacity for multiphasic acquisition2. Triphasic MDCT exploits the dual blood supply of the liver, approximately 75–80% portal venous and 20–25% hepatic arterial, to characterize lesions by their vascularity across non-contrast, arterial, portal venous, and delayed phases3. Distinct phase-specific enhancement patterns permit differentiation of hypervascular tumors such as HCC from hypovascular or cystic lesions, and allow recognition of pathognomonic patterns such as the peripheral nodular enhancement with centripetal fill-in of hemangiomas. This study evaluated the diagnostic utility of triphasic MDCT in characterizing focal liver lesions, correlating enhancement patterns with the final CT diagnosis and background hepatic parenchyma.

Materials and Methods

This prospective observational study was conducted in the Department of Radiodiagnosis, MGM Medical College and Hospital, Kamothe, Navi Mumbai, over a two-year period after Institutional Ethics Committee approval, in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants. Using Cochran's formula, a sample size of 85 was calculated.

Patients above 18 years of age referred with ultrasound, laboratory, or clinical evidence of liver lesions were included. Patients with a contraindication to iodinated contrast, a known histological diagnosis, inconclusive biopsy results, trauma-related hepatic lesions, or unwillingness to consent were excluded.

All patients underwent CT on a 128-slice MDCT scanner with 5-mm axial sections. A non-contrast scan was followed by dynamic contrast-enhanced imaging, with arterial phase images acquired at 30–40 seconds, portal venous phase at 70 seconds, and delayed/equilibrium phase at 180 seconds after intravenous contrast administration. A structured proforma recorded lesion number, size, density, phase-wise enhancement pattern, background liver parenchyma, biliary and vascular status, and associated abdominal findings.

Data were entered in Microsoft Excel and analyzed using SPSS version 21. Quantitative variables were expressed as mean, median, and standard deviation, and categorical variables as frequencies and percentages. The two-tailed Student's t-test was used to test significance, with $p<0.05$ considered statistically significant.

Results

Of the 85 patients studied, 36.5% were aged 20–40 years, 35.3% were 41–60 years, and 28.2% were 61–80 years, with a slight female predominance (52.9%). Lesions were most often detected incidentally (23.5%), followed by jaundice (21.2%), weight loss (18.8%), abdominal pain (16.5%), and abdominal distension (15.3%).

A solitary lesion was present in 28.2% of patients; the remainder had multiple lesions, most frequently in metastatic disease (86.7% multifocal). On non-contrast CT, lesions were hypodense in 43.5%, of mixed density in 30.6%, hyperdense in 23.5%, and cystic in 2.4%. Background parenchyma was normal in 62.4%, cirrhotic in 25.9%, and fatty in 11.8% of patients.

In the arterial phase, 37.6% of lesions enhanced, 16.5% enhanced peripherally, 42.4% were non-enhancing, and 3.5% enhanced heterogeneously. In the portal venous phase, 27.1% remained enhancing, 21.2% reached equilibrium, 10.6% showed gradual fill-in, and 36.5% were non-enhancing; in the delayed phase, 41.2% enhanced and 44.7% remained non-enhancing.

The final CT diagnosis was hemangioma in 20.0% (17/85), metastasis in 17.6% (15/85), HCC in 16.5% (14/85), FNH and simple cyst in 12.9% each (11/85), abscess in 8.2% (7/85), cholangiocarcinoma and hepatic hematoma in 3.5% each (3/85), and biliary hamartoma and hepatic adenoma in 2.4% each (2/85) (Table 1, Fig. 2).

Table 1: Distribution of final CT diagnoses among 85 patients with focal liver lesions.

CT diagnosis	n	%
Hemangioma	17	20.0
Metastasis	15	17.6
Hepatocellular carcinoma	14	16.5
Focal nodular hyperplasia	11	12.9
Simple cyst	11	12.9
Abscess	7	8.2
Cholangiocarcinoma	3	3.5
Hepatic hematoma	3	3.5
Biliary hamartoma	2	2.4
Hepatic adenoma	2	2.4
Total	**85**	**100.0**

Lesion type correlated strongly with enhancement pattern (Fig. 1). HCC showed arterial enhancement in 64.3%, with washout in the venous or delayed phase in 57.1%; 54.5% of HCCs occurred in cirrhotic livers, a significant association with background parenchyma ($p<0.001$). Hemangiomas showed peripheral nodular arterial enhancement in 47.1%, progressive centripetal fill-in on the venous phase (47.1%), and near-complete fill-in by the delayed phase (88.2%). Metastases showed heterogeneous enhancement, enhancing in 46.7% and non-enhancing in 53.3% during the arterial phase. Abscesses characteristically showed peripheral rim enhancement (71.4%) with a non-enhancing necrotic centre. Biliary hamartomas and hepatic hematomas were uniformly non-enhancing across all phases.

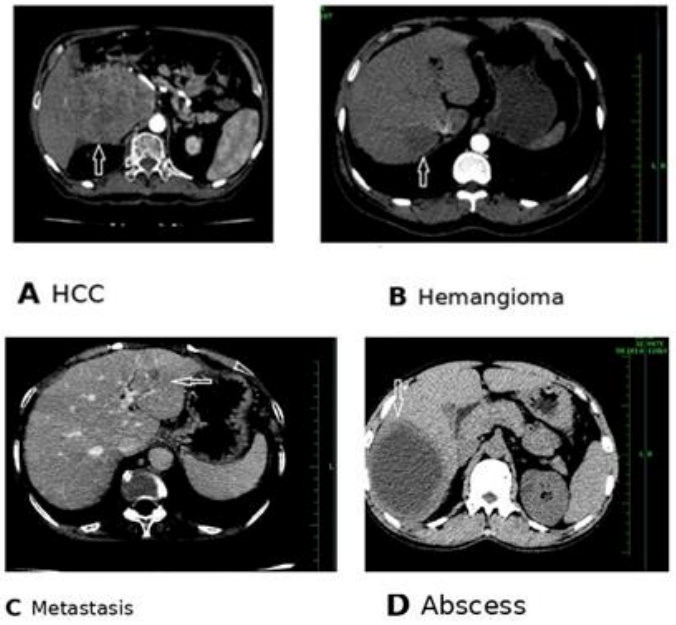

Figure 1: Representative contrast-enhanced axial CT images illustrating characteristic lesion-specific enhancement. (A) Hepatocellular carcinoma showing arterial-phase enhancement in a cirrhotic liver. (B) Hemangioma with peripheral nodular enhancement. (C) Hepatic metastasis with heterogeneous parenchymal enhancement. (D) Liver abscess with a peripherally enhancing, thick-walled hypodense collection. Arrows indicate the index lesion in each panel.

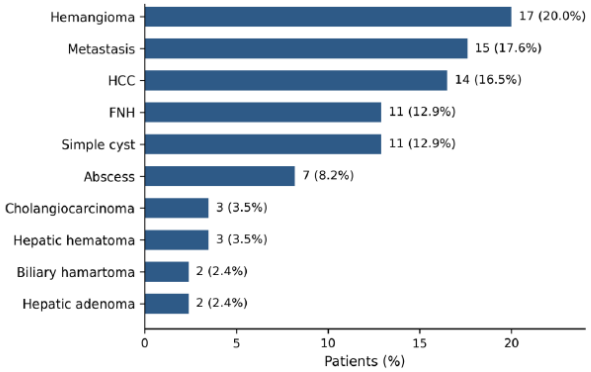

Figure 2: Bar chart showing the distribution of final CT diagnoses among the 85 study patients. FNH, focal nodular hyperplasia.

Discussion

This study of 85 patients corroborates the established role of triphasic MDCT in hepatic lesion characterization

through phase-specific enhancement analysis. The near-equal age distribution and slight female preponderance in our cohort parallels the findings of Matos et al.,[4] though it contrasts with the male predominance reported by Prashanth et al.[5] The high proportion of incidentally detected lesions (23.5%) reflects the increasing use of cross-sectional imaging and parallels the 22.8% reported by Yoon et al.[6]

HCC demonstrated the classic pattern of arterial hyperenhancement with washout, seen in 64.3% of cases here, somewhat lower than the 78–90% reported by Kim et al. and in AASLD guidelines,[7,8] possibly reflecting differences in lesion size and bolus timing. The strong association between HCC and cirrhosis (54.5%) reaffirms established pathogenesis, although it is lower than the 80–90% described globally,[9] suggesting regional variation in HCC etiology.

Hemangiomas exhibited the pathognomonic peripheral nodular enhancement with centripetal fill-in, a pattern with reported specificity approaching 96%,10 though observed in a smaller proportion of cases here (47.1%) than the 63% described by Semelka et al.,[10] likely reflecting a preponderance of smaller lesions. Metastases showed heterogeneous, frequently multifocal enhancement consistent with variable primary tumor vascularity,[11] underscoring the value of whole-liver assessment in oncology patients.

Diagnostic difficulty was chiefly encountered with small (<1 cm) arterially enhancing lesions in cirrhotic liver, where regenerative or dysplastic nodules may mimic early HCC, and with hypovascular metastases resembling simple cysts; such cases warrant MRI or interval follow-up. Fatty change and severe cirrhosis reduced lesion–parenchyma contrast, consistent with prior reports.[12]

Limitations include the single-centre design, absence of universal histopathological confirmation, and reliance on imaging-based diagnosis, mirroring real-world practice where pathognomonic lesions are not routinely biopsied. Integration of dual-energy CT and AI-assisted lesion characterization may further refine diagnostic performance.

Conclusion

Triphasic MDCT provides reliable, non-invasive characterization of focal liver lesions through distinct phase-specific enhancement patterns, with hemangioma, metastasis, and HCC constituting the commonest diagnoses in this cohort. Its wide availability, rapid acquisition, and strong correlation between enhancement dynamics and lesion type support its role as a first-line modality in hepatic lesion evaluation and in guiding the selective use of further imaging or biopsy.

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